VEHICLE NAVIGATION SYSTEM
ADAPTED TO IMPROVED SYSTEM UPGRADE PROCEDURE

Background of the Invention

5   ### 1. Field of the Invention

The present invention is related to a vehicle navigation system, in particular, to a technique for upgrade of a vehicle navigation system.

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2. Description of the Related Art

Vehicle navigation systems are provided with storage devices containing navigation software programs and map data.

15   A hard disk drive is a typical storage device used in a vehicle navigation system. A navigation system with a built-in hard disk drive uses a navigation program and map data stored in a hard disk drive to navigate a vehicle to a

20 destination.

One of drawbacks of a navigation system with a built-in hard disk drive is that the navigation system can not work during upgrade. Upgrading a navigation system with a built-in

25 hard disk drive involves detaching the hard disk drive, updating the navigation program and the map data within the hard disk drive, and

restoring the hard disk drive to the system.
Detaching the hard disk drive prohibits the
navigation system from operating during the
upgrade. This implies that a navigation system
5 with a built-in hard disk drive is forced to quit
navigating the vehicle during upgrade of the
system. Furthermore, this upgrade procedure
undesirably requires the user to hand over the
vehicle to the dealer to have the hard disk drive
10 updated.

Therefore, a need exists to provide a
technique for effectively reducing duration when
a navigation system is forced to quit operating
in order to upgrade the system.

15 An optical disk drive, such as a DVD-ROM
drive, is another a typical storage device used
in a vehicle navigation system. A navigation
system with a built-in DVD-ROM drive uses a
navigation program and map data stored in a DVD-
20 ROM to navigate a vehicle to a destination.
Upgrading a navigation system with a built-in
DVD-ROM drive can be achieved by replacing the
DVD-ROM with a new DVD-ROM containing a new
navigation program and new map data. Therefore, a
25 navigation system with a built-in DVD-ROM drive
is superior to that with a built-in hard disk
drive in terms of necessary duration for upgrade

of the system. Nevertheless, DVD-ROM drives are inferior to hard disk drives in terms of access time, and this undesirably leads to a slow operation speed of the system. Therefore, a
5 navigation system desirably operates using a hard disk drive to improve operation speed.

Navigation systems provided with both a hard disk drive and a DVD-ROM drive are disclosed in Japanese Unexamined Patent Applications No.
10 2001-133273 and 2001-165671. The disclosed navigation systems transfer map data stored in a DVD-ROM to a hard disk drive, and executes vehicle navigation using transferred map data within the hard disk drive. These navigation
15 systems allows users to play another DVD-ROM during vehicle navigation.

Japanese Unexamined Patent Application No. 2000-251396 discloses an in-vehicle information processing unit for achieving reliable data write
20 into a hard disk drive.

Summary of the Invention

An object of the present invention is to provide a vehicle navigation system for reducing
25 time during which the system is forced to quit operation and the user is prohibited from using the system when upgrading the system.

Another object of the present invention is to provide a vehicle navigation system for achieve both improvement of an operation speed and reduction of the time during which the system is forced to quit operation when upgrading the system.

In an aspect of the present invention, a vehicle navigation system is composed of first and second recording devices, first and second execution modules, and an install module. The first and second recording devices respectively store therein first and second computer programs each of which is used for vehicle navigation. The first and second execution modules respectively execute the first and second computer programs. The install module transfers data stored in the second recording device, including the second computer program, to the first recording device. The install module is allowed to operate during operation of the second execution module, while the first execution module is prohibited from operating during operation of the second execution module.

The navigation system usually navigates a vehicle to the destination using the first computer program. This architecture allows the navigation system to execute vehicle navigation

during update the first computer program to the second computer program, and effectively reduces duration when the system is forced to quit vehicle navigation.

5   Preferably, the first recording device has a read access time shorter than that of the second recording device. This effectively improves the operation speed of the navigation system compared to the system only having the
10 second recording device.

The first recording device typically includes a hard disk drive, and the second recording device typically includes an optical disk drive, such as a DVD-ROM drive and a CD-ROM
15 drive, which uses an easily detachable recording medium.

The install module preferably transfers the data from the second recording device to the first recording device in units of data blocks,
20 each having a predetermined data size. In general, software for vehicle navigation has a large data size. Transfer of such software in units of the data blocks effectively reduces duration when the install module prohibits the operation of the
25 second execution module, especially in the event that the file size of the software is quite large.

The navigation system advantageously

includes a display management module adapted to
display information on a data size of the data to
be transferred to the first recording device on a
display device. The display management module may
5 display the data size itself or a ratio of the
data size of the data to be transferred to data
size of the whole of the data stored in the
second recording device.

It would be also advantageous if the
10 navigation system includes a display management
module adapted to display a necessary duration
for completing transfer of whole of the data to
the first recording device on a display device.

In another aspect of the present invention,
15 a method for upgrading a vehicle navigation
system including an optical disk drive and a hard
disk drive includes:

determining whether an optical disk storing
an updated navigation program is mounted on the
20 optical disk drive;

executing an original navigation program
stored in the hard disk drive when the optical
disk is not mounted;

executing the updated navigation program
25 stored in the optical disk drive in response to
the optical disk being mounted; and

updating the navigation program through

installing the updated navigation program into the hard disk drive during execution of the update navigation program.

Brief Description of the Drawings

Fig. 1 is a block diagram of a navigation system in one embodiment of the present invention;

Fig. 2 is a block diagram schematically illustrating data stored in a hard disk drive;

Fig. 3 is a block diagram of a main unit of the navigation system; and

Fig. 4 is a flowchart illustrating a software install procedure in this embodiment.

Description of the Preferred Embodiments

Preferred embodiments of the present invention are described below in detail with reference to the attached drawings.

In one embodiment, as shown in Fig. 1, a navigation system 10 is composed of a main unit 11, a hard disk drive (HDD) 12, a DVD-ROM drive 13, a memory card 14, a navigation sensor 15, an output device 16, an input device 17, and a radio communication device 18. The navigation system 10 is mounted on a vehicle (not shown).

The main unit 11 is an information

processing unit (or a computer) provided with a volatile memory device used for storage of software, and a central processing unit (CPU) for executing the software. The software includes a

5   computer program and data used during execution of the computer program.

The hard disk drive 12 is a non-volatile storage device used for storing the software. The hard disk drive 12 is responsive to instructions

10   from the main unit 11 for storing the software, and for outputting and deleting the software stored therein.

The DVD-ROM drive 13 reads out software from a DVD-ROM disk 19, and provides the software

15   for the main unit 11.

The memory card 14 is used to store software, and responsive to instructions from the main unit 11 for storing software, and for outputting and deleting the software stored

20   therein.

The navigation sensor 15 obtains data for determining the position of the vehicle. The navigation sensor 15 may include a GPS antenna and a gyroscope.

25   The output device 16 is used to provide various information generated by the main unit 11 for users, including drivers and fellow

passengers. The output device 16 may include a liquid crystal display and a speaker.

The input device 17 is provided for operation of the users to input instructions into the main unit 11 of the navigation system. The input device 17 may include a microphone, a keyboard, and a touch panel.

The radio communication device 18 provides the main unit 11 with connections to the Internet through a cellular telecommunication network. The radio communication device 18 is designed to transfer information received from the main unit 11 to a terminal through the Internet, and to transfer information received from a server through the Internet to the main unit 11.

The main unit 11 is connected to a plurality of electronic control units (ECU) 27 and network sensors through an in-vehicle local area network 21. The ECUs 27 are used for controlling various apparatuses of the vehicle. The ECUs 27 may include an engine electronic control unit, a transmission electronic control unit, a power steering system electronic control unit, an ABS (antilock break system) electronic control unit, an air bag electronic control unit, an air conditioner electronic control unit, and a constant speed cruise electronic control unit.

The network sensors includes a speed sensor 22, an acceleration sensor 23, a temperature sensor 24, a voltage sensor 25, and a tachometer 26. The speed sensor 22 determines the speed of the

5   vehicle. The determined speed is provided for the transmission electronic control unit, the power steering system electronic control unit, the ABS electronic control unit, and the constant speed cruise electronic control unit. The acceleration

10   sensor 23 determines the acceleration of the vehicle. The determined acceleration is provided for the air bag electronic control unit. The temperature sensor 24 determines the temperature in the vehicle. The determined temperature is

15   provided for the air conditioner electronic control unit. The voltage sensor 25 determines the output voltage of a battery of the vehicle. The tachometer 26 determines the rotation speed of the engine of the vehicle. The determined

20   rotation speed is provided for the engine electronic control unit.

Fig. 2 shows data stored in the hard disk drive 12. The data within the hard disk drive 12 is composed of a navigation software set 31, a

25   learned data 32, and a virtual memory data 33. The navigation software set 31 is a set of computer programs and data used for vehicle

navigation. The navigation software set 31 allows
the navigation system 10 to measure the position
of the vehicle, to specify the road along which
the vehicle is travelling, to determine an

5 optimum route along which the vehicle reaches the
destination, and to inform the users of the
optimum route. The learned data 32, which is
generated by the navigation software set 31,
includes data on the past destinations, user-

10 specific data and other data. The virtual memory
data 33 is used for a virtual memory technique.
An operating system installed in the main unit 11
develops the virtual memory data 33 on the hard
disk drive 12 to achieve a virtual memory

15 operation.

The navigation software set 31 includes a
first navigation program 34, a second navigation
program 35, and navigation data 36. The first
navigation program 34 is repeatedly or

20 periodically executed. The first navigation
program 34 includes a computer program designed
to determine the position of the vehicle, to
specify the road along which the vehicle is
travelling, and to inform the users of the

25 specified road with the output device 16. The
second navigation program 35 is executed in
response to occurrence of predetermined events.

The second navigation program 35 includes a computer program designed to plan a route to a destination in response to input of the destination by the users, to replan the route to

5 the destination in response to the vehicle getting out of the planned route, to provide the users with a guidance of the correct direction in response to the vehicle approaching an intersection, and to execute voice recognition of

10 spoken instructions provided by a user to operate in accordance with the spoken instructions. The navigation data 36, which is used by the first and second navigation programs 34 and 35, includes map data representative of arrangement

15 of roads. The map data is accompanied by information on the state of the roads, including asphalt-paved roads, dirt roads, and wavy paved roads. The navigation data 36 further includes data used for voice recognition, and data used

20 for achieving a 3D display of the proposed route.

The DVD-ROM disk 19 is used for installing an updated version of the navigation software set 31. The updated version includes first and second navigation programs and navigation data, as is

25 the case with the navigation software set 31. The first navigation program stored in the DVD-ROM disk 19 is an updated version of the first

navigation program 34, which is repeatedly or periodically executed. The second navigation program stored in the DVD-ROM disk 19 is an updated version of the second navigation program

5   35, which is executed in response to the occurrence of the predetermined events. The navigation data stored in the DVD-ROM disk 19 is an updated version of the navigation data 36. The updated navigation data within the DVD-ROM disk

10   19 is adapted to the updated first and second navigation programs.

Fig. 3 shows details of the main unit 11 of the navigation system 10. The main unit 11 includes a HDD based program executing module 41,

15   a DVD-ROM based program executing module 42, an install module 43, and a display management module 44. These modules are computer programs stored in a non-volatile memory disposed in the main unit 11. The HDD based program executing

20   module 41 starts software programs stored in the hard disk drive 12. The DVD-ROM based program executing module 42 starts software programs stored in the DVD-ROM disk 19. The install module 43 transfers software stored in the DVD-ROM disk

25   19 to the hard disk drive 12 to update the software within the hard disk drive 12. The install module 43 is allowed to be executed

during execution of the DVD-ROM based program
executing module 42. The display management
module 44 is used for providing users with
various information on the update of the software.

5 The display management module 44 calculates a
current ratio of the data size of the already
transferred portion of the software to the data
size of the whole of the software to be
transferred, and necessary time for completing

10 the transfer of the remainder of the software.
The display management module 44 depicts the
calculated ratio and the calculated duration on a
display device.

The operation of the navigation system 10

15 involves the navigation of the vehicle to the
destination and the install of the updated
software. The vehicle navigation is achieved by
the navigation software set 31 stored in the hard
disk drive 12, without using the DVD-ROM drive 13.

20 During navigation on the basis of the hard disk
drive 12, the users are allowed to mount an audio
or video DVD-ROM disk on the DVD-ROM drive 13 to
play the disk.

Fig. 4 is a flowchart of the upgrade of the

25 navigation system 10. To upgrade the navigation
system 10, the user is requested to purchase a
DVD-ROM 19 storing therein the updated version of

the navigation software set 31. In response to
the purchased DVD-ROM 19 being mounted on the
DVD-ROM drive 13, at Step S1, the main unit 11
determines whether the install of the updated

5   version is allowed. For example, the main unit 11
determines whether the user operates the
navigation system 10 to start the install, and
whether the DVD-ROM 19 storing the updated
version is mounted on the DVD-ROM drive 13.

10   When the main unit 11 determines that the
install of the updated version is not allowed at
Step S1, the main unit 11 quits the install, and
allows the HDD based program executing module 41
to start vehicle navigation using the navigation

15 software set 31 within the hard disk drive 12 at
Step S2.

          Otherwise, the main unit 11 concurrently
executes the install and the vehicle navigation
at Step S3. The main unit 11 allows the install

20 module 43 to transfer the updated navigation
software set from the DVD-ROM disk 19 to the hard
disk drive 12, while allowing the DVD-ROM based
program executing module 42 to execute vehicle
navigation using the updated navigation software

25 set stored in the DVD-ROM disk 19. The main unit
11 transfers the updated navigation set during
idle time of the vehicle navigation. The updated

navigation set is desirably transferred in units
of data blocks, each having a predetermined data
size. The data block may consists of a plurality
of sectors of the DVD-ROM disk 19. In an
5   alternative embodiment, the main unit 11 may
execute the install and the vehicle navigation
through time-shared operations. After the
completion of the install of the updated version,
the main unit 11 starts vehicle navigation using
10 the updated navigation software set stored in the
hard disk drive 12.

This install procedure effectively reduces
the time during which the navigation system 10 is
forced to quit vehicle navigation when upgrading
15 the system. Conventionally, an upgrade of a
navigation system with a built-in hard disk drive
involves detaching the hard disk drive and
installing updated software into the detached
hard disk drive; otherwise the upgrade of the
20 navigation system involves quitting vehicle
navigation and installing the updated software
into the hard disk drive through the DVD-ROM
drive. This results in that the conventional
navigation system suffers from a drawback that
25 the conventional navigation system can not
execute vehicle navigation during the upgrade the
system. The navigation system 10 concurrently

executes the vehicle navigation on the basis of the updated version of the software set stored in the DVD-ROM disk during the install of the updated version. This effectively reduces the

5 time during which the navigation system 10 is forced to quit vehicle navigation when upgrading of the system.

In addition, the navigation system 10 is superior in the operation speed. As mentioned

10 above, the navigation system 10 uses the navigation software set stored the hard disk drive 12 during normal operations. The fast access speed of the hard disk drive 12 effectively improves the operation speed of the

15 navigation system 10.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been changed

20 in the details of construction and the combination and arrangement of parts may be resorted to without departing from the scope of the invention as hereinafter claimed.